On the mechanics of tonogenesis

On the mechanics of tonogenesis: Evidence from prevoicing

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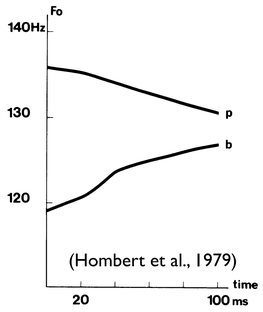
INTRODUCTION

Obstruent-intrinsic F0 effect:
F0 of vowels following voiced stops lower than F0 following voiceless stops

Stage 1	*Stage 2*	*Stage 3*
pá [—]	pá [—]	pá [—]
bá [⌒]	bă [⌒]	pă [⌒]

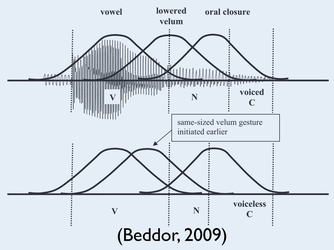
Phonologization of F_0 (after Hyman, 1976).



(Hombert et al., 1979)

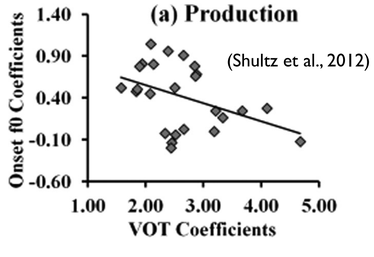
- Implicated in emergence and evolution of tone systems
- What factor(s) might contribute to exaggeration of this effect?
- Kingston & Diehl (1994): onset F0 is **actively lowered** to enhance the perception of the [voice] contrast

- If onset F0 is under speaker control, it might be in a **trading relation** with VOT (Repp, 1982)
- If informativity of F0 increases as that of VOT decreases, listeners might misattribute the source of the effect (Beddor, 2009; Solé, 2014)



(Beddor, 2009)

- Shultz et al. (2012) present evidence of just such a relation between VOT and F0 for (phonetically **voiceless**) English stops
- Replicated (by us) in pilot

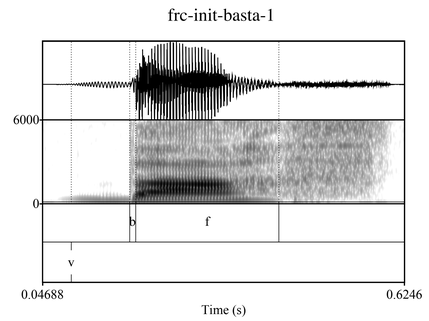


(Shultz et al., 2012)

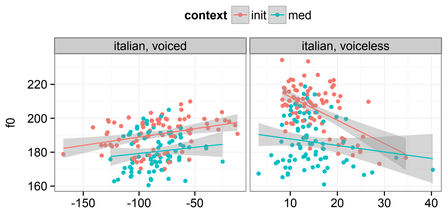
Does there exist a similar trading relation between **voicing lead** and F0?

MATERIALS & METHODS

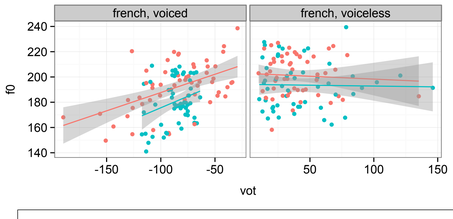
- 5 female speakers each of French & Italian
- 3 repetitions each of 11 (near-) minimal triplets: two bilabial target items (e.g. *balla ~ palla, boule ~ poule*) and one rhyming distractor (e.g. *stalla, foule*) in initial and medial positions
- Vowels were mainly /a/, with a few /ɛ/s and (for French) /u/s
- Durational measures: **v**oicing onset, **b**urst onset/offset, duration of **f**ollowing vowel
- Spectral measures: F0 at seven timepoints starting 10ms after vowel onset (start of **f**)



RESULTS



F0 at 10ms after voicing onset by context



Italian

	Estimate	*SE*	*df*	*t*	*Pr(>|t|)*
(Intercept)	196.46	2.07	112.4	94.91	**<0.001**
c.(vot)	0.12	0.036	293.04	3.23	**0.0014**
voice=voiceless	49.38	8.45	313.17	5.85	**<0.001**
context=medial	-15.08	1.28	316.19	-11.77	**<0.001**
c.(vot):voice=voiceless	-0.93	0.17	315.81	-5.52	**<0.001**
c.(vot):context=medial	-0.09	0.02	314.57	-3.58	**0.0004**

French

	Estimate	*SE*	*df*	*t*	*Pr(>|t|)*
(Intercept)	209.54	5.0	27.0	41.85	**<0.001**
c.(vot)	0.29	0.07	35.19	4.0	**<0.001**
voice=voiceless	4.42	7.8	23.18	0.57	0.57
context=medial	-8.91	2.27	196.22	-3.93	**<0.001**
c.(vot):voice=voiceless	-0.5	0.12	100.35	-4.69	**<0.001**
c.(vot):context=medial	0.05	0.03	201.81	1.34	0.18

Finding in **opposite direction** to predicted effect

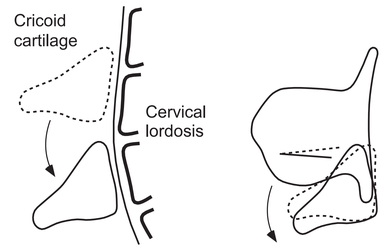
- **Positive** correlation between duration of voicing lead and onset F0 in both languages; onset F0 for [+voice] lower in medial context
- `F0 ~ VOT + voicing + context + (VOT:voicing) + (VOT:context) + (1+VOT|subject) + (1|item)`

DISCUSSION

No evidence for trading relation: speakers tend to use **more** low F0 as voicing lead time **increases**

Consistent with primarily automatic account of onset F0 effects, e.g.:

- Larynx and hyoid bone are consistently lower for voiced stops than for voiceless (Kent & Moll, 1969)
- Accompanied by downward movement of the cricoid cartilage and slackening of the vocal folds (Honda, 2004)



(Honda 2004, Fig. 6)

However, relationship between voicing and F0 still important for the emergence and evolution of tone

- Maintaining prevoicing is aerodynamically challenging; lowering of larynx could prolong prevoicing while also lowering onset F0, consistent with present findings
- If the low-frequency pulsing is not perceived, percept could instead be of a low- vs high-F0 [-voice] stop

Misattribution of coarticulatory source need not involve **active** enhancement or trading relation

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Beddor, P. S. 2009. A coarticulatory path to sound change. *Language* 85(4): 785-821. / Hombert., J.-M., Ohala, J. J., Ewan, W.G. 1979. Phonetic explanations for the development of tones. *Language* 55(1):37-58. / Honda, K. 2004. Physiological factors causing tonal characteristics of speech: from global to local prosody. In *Proc. Speech Prosody* 2004, 739-744. / Kent, R.D., Moll, K. L. 1969. Vocal tract characteristics of the stop consonants. *JASA* 59:1548-1555. / Kingston, J., Diehl, R. 1994. Phonetic knowledge. *Language* 70(3): 419-454. / Repp, B. 1982. Phonetic trading relations and context effects: new experimental evidence for a speech mode of perception. *Psychological Bulletin* 92(1): 81-110. / Shultz, A.A., Francis, A. L., Llanos, F. 2012. Differential cue weighting in perception and production of consonant voicing. *JASA Express Letters* 132(2): EL95-EL101. / Solé, M.-J. 2014. The perception of voice-initiating gestures. *Laboratory Phonology* 5(1):37-68.

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